Emotion-inducing imagery versus motor imagery based BCI: performance, perceived control and imagery preference

3-C-14 Emotion-inducing imagery versus motor imagery based BCI: Performance, perceived control and imagery preference

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Introduction: An initial preliminary investigation into alternative imagery strategies to motor imagery (MI) for modulating brain activity for brain-computer interface (BCI) control [1] suggested emotioninducing imagery (EII) could offer comparable performance to motor imagery. Here we present a more comprehensive analysis of the viability of EII, comparing multiple online feedback sessions and singletrial classification accuracy (CA) for EII tasks vs MI with 10 participants, scheduled across different days. Beside the CA comparison, we compare the participants´ subjective responses on favourite control approach and the imagery with most perceived control over feedback provided during the experiment. Material, Methods and Results: Electroencephalogram (EEG) data were recorded from 30 electrodes, mounted based on 10-20 system, with 125Hz sampling rate. The Study involved 10 healthy volunteering participants (2 females and 8 males, mean age 29, SD = 8). Each session, as previously reported in [1], includes a calibration run and feedback run for EII and MI, i.e. 4 runs per session. In EII runs, participants recalled a real or imagined fictitious happy event and sad event for each class (left or right cue), happy. Happy and sad emotions were used as they are likely to be associated with hemispheric asymmetric activation [2] which may enhance separability between classes. For MI runs, participants imagine left hand movement and right hand movement. Each run had 60 trials, 30 for each class. Each participants participated in 3 to 5 sessions. In feedback runs, a continuous feedback was provided using a game in which the character moved along the horizontal axis to collect spikes falling on the left or right side on the screen. At the end of the session, the participant is asked, via a questionnaire, what their favourite control approach was and which imagery strategy was perceived to provide most control over the game character. The online single-trial CA for feedback runs averaged across sessions for each participant are reported in Figure 1(a). Most of the participants achieved acceptable performance (CA > 70%) with EII in at least one of their sessions, but this performance was not maintained in other sessions leading to overall low CA across sessions. Wilcoxon signed rank test showed that for MI CA averaged across sessions are significantly higher than EII CA ($p < 0.05$). The subjective responses showed that participants preferred MI to EII in 89.19% of the total sessions across participants, and MI was the approach with most perceived control in 87.84% of the total sessions. Each participant´s votes for favourite and approach with most perceived control are shown in Figure 1(b) and Figure 1(c), respectively. Discussion: The aim of this study was to investigate the comparable performance of EII and MI previously reported in single-session based studies [1] is maintained in multiple sessions with online feedback. The results show that performance with MI is significantly higher than EII. Additionally, participants prefer MI to EII as a BCI control approach, and this preference is likely influenced by difficulty experienced in executing EII tasks that involve accessing repeatedly same events in the memory in limited amount of time. This difficulty might be the reason why the one participant who maintained EII CA across sessions (ay) did not vote even once for EII as the favourite approach or approach with most perceived control over the feedback. Significance: The current multiple sessions study suggests that emotion-inducing imagery is not yet a viable alternative imagery to motor imagery for BCI control strategy for the majority of subjects. Further investigation is needed to identify effective EII tasks that might be easy to execute in a BCI paradigm. References [1] A. D. Bigirimana, N. Siddique, and D. Coyle, "Brain-Computer Interfacing with Emotion-Inducing Imagery: A Pilot Study," in 7th Graz Brain-Computer Interface Conference (GBCIC), 2017. [2] R. J. Davidson, P. Ekman, C. D. Saron, J. A. Senulis, and W. V Friesen, "Approach withdrawal and cerebral asymmetry:

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